# Contemporary Carbon Dynamics in U. S. Terrestrial Biosphere: I. The Southeastern Plains Ecoregion

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## Background

- The continuous increase of atmospheric CO2 concentration is one of the most serious environmental threats to the Earth system and the economy of our society, because it will likely contribute to global warming.
- The role of terrestrial biosphere in the global carbon (C) cycle is not well understood and quantified.
- U.S. carbon sources and sinks are not well quantified, mainly owing to the lack of consistent, high-quality land cover/use change databases and appropriate scaling strategy.

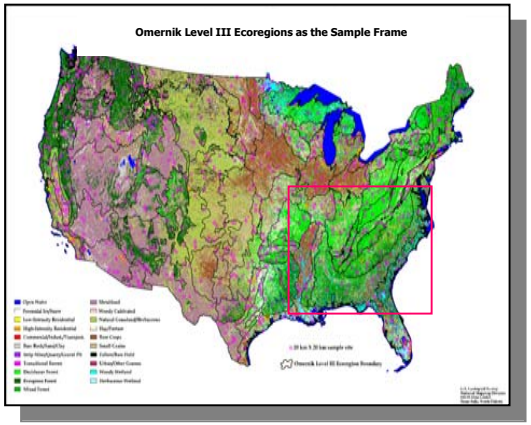
## Goal

Identify the **spatial and temporal distributions of carbon sources and sinks** in the conterminous U.S. with measures of uncertainties

## Approach

### Domains

**Spatial: conterminous U.S.**
**Temporal: 1973 to 2000**




### Sampling Strategy & Land Cover/Use Change

- Wall-to-wall mapping approach for quantifying land cover/use change over large areas is challenging.
- A low cost sampling strategy based on Omernik ecoregions is used.
- Sampling blocks are randomly selected for each of the 84 ecoregions to identify changes more than 1 percent in cover within each ecoregion at an 85 percent confidence level.
- The analysis of land cover change is based on five dates of Landsat MSS, TM, and ETM data (nominally 1973, 1980, 1986, 1992 and 2000).

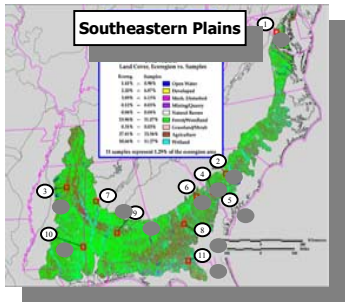
### Carbon Biogeochemical Modeling

**Model: GEMS** Ensemble biogeochemical Modeling System (GEMS) is developed at EROS Data Center for applications over large areas.

- Model simulation is performed at a length scale of 60 m.
- A modified version of the ecosystem model CENTURY is the underlying ecosystem biogeochemical model.
- GEMS deploys CENTURY in space on the basis of the joint frequency distribution of major input variables.
- GEMS has the capability of assimilating various data from different sources.
- Multiple stochastic model simulations can be used to quantify the impacts of data variability (both variance and covariance) and uncertainty on model simulations.

### Supporting Databases

**Soil:** State Soil Geographic (STATSGO) database (texture, soil organic matter content, bulk density, etc.)
**Climate:** products from the Vegetation/Ecosystem Modeling and Analysis Project (VEMAP)
**Land use/cover change:** USGS/NASA/EPA Land Cover Trends Project
**Agriculture:** USDA agricultural census data at the county level (crop composition, rotation probability, etc.)
**Forestry:** USDA Forest Service Forest Inventory and Analysis databases (age distribution, C stock, growth, mortality, harvest, etc.)
**Atmospheric nitrogen deposition:** National Atmospheric Deposition Network



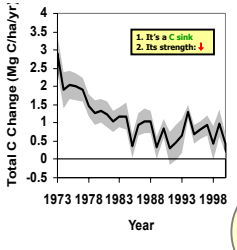

- **Land cover/use change in the SE Plains ecoregion has been intensifying since 1970s (more urbanization and forest harvesting, reduction of agricultural land).**
- **SE Plains has been a carbon sink since the early 1970s, but the C sink has been reduced by 65% from 1970s to 1990s.**
- **The relative contributions of biomass, SOC and harvested wood carbon (HWC) to the regional C sink has been changing from 1970s to 1990s.**
- **The major driving forces for the reduction of C sink are forest aging and intensification of timber harvesting.**
- **This study provides a solid biogeochemical modeling framework for projecting carbon dynamics in the SE Plains and other regions under various climate and management scenarios.**
- **The sampling-based approach is scalable and can be applied to regional to global scales.**

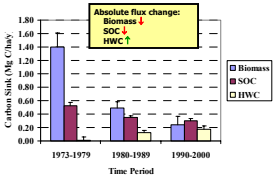
### Land Cover/Use Change

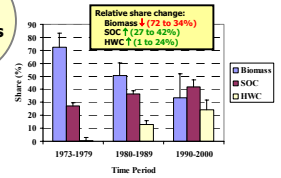
Agriculture: ↓ (24.8 to 21.7%)
Urban: ↑ (8.4 to 9.8%)
Disturbed: ↑ (2.2 to 4.8%)
Others: stable

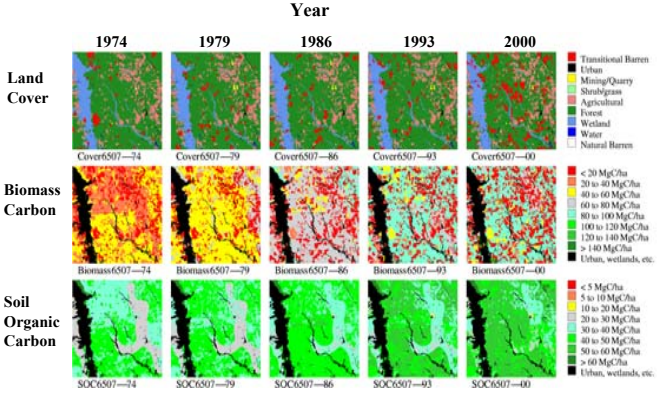
| Category | 1973 | 1980 | 1986 | 1992 | 2000 |
|---|---|---|---|---|---|
| Water | 1.0 | 1.0 | 1.1 | 1.0 | 1.1 |
| Developed | 8.4 | 8.6 | 8.9 | 9.1 | 9.8 |
| Disturbed | 2.2 | 2.4 | 2.9 | 3.8 | 4.8 |
| Mining | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Forest | 53.4 | 52.5 | 52.0 | 52.7 | 52.5 |
| Grass/Shrub | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Agriculture | 24.8 | 25.2 | 24.8 | 22.9 | 21.7 |
| Wetland | 10.2 | 10.3 | 10.3 | 10.3 | 10.0 |

### Carbon Dynamics




**Land cover, simulated biomass carbon and soil organic carbon (SOC) within sample block 6507 (20x20 km²) in the Southeastern Plains Ecoregion in 1974, 1979, 1986, 1993 and 2000. Biomass carbon in 1974 was initialized with data from the U.S. Forest Service Forest Inventory and Analysis database. SOC in 1974 was estimated from the STATSGO soil database. The spatial and temporal patterns of biomass carbon change carbon clearly show forest clearcutting activities (some highlighted by the blue arrows) and subsequent accumulation of carbon in regrowing forests (see the area within the white circles). Five Monte Carlo simulations were performed for each JFD case.**

## Acknowledgement

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